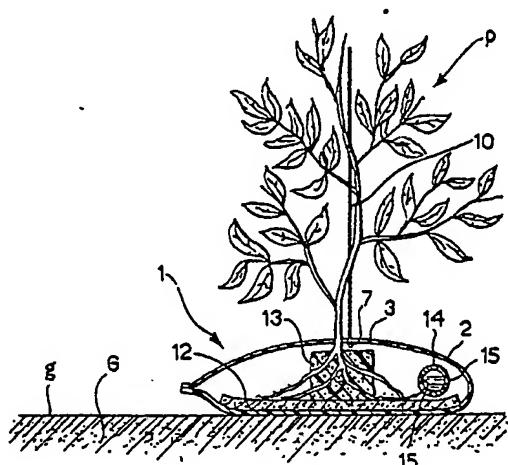


INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁴ : A01G 31/02	A1	(11) International Publication Number: WO 86/ 00494 (43) International Publication Date: 30 January 1986 (30.01.86)
(21) International Application Number: PCT/EP85/00340 (22) International Filing Date: 11 July 1985 (11.07.85) (31) Priority Application Number: 67716-A/84 (32) Priority Date: 16 July 1984 (16.07.84) (33) Priority Country: IT (71) Applicant (for all designated States except US): GREEN HAS S.r.l. [IT/IT]; Corso Moncalieri 77, I-10133 Torino (IT). (72) Inventor; and (75) Inventor/Applicant (for US only) : GIOVANDO, Gualtiero [IT/IT]; Casa Solare, I-12065 Monforte d'Alba (Cuneo) (IT). (74) Agents: JACOBACCI, Filippo et al.; Jacobacci-Casetta & Perani S.p.A., Via Alfieri 17, I-10121 Torino (IT).		(81) Designated States: AT (European patent), AU, BE (European patent), CF (OAPI patent), CG (OAPI patent), CH (European patent), CM (OAPI patent), DE (European patent), FR (European patent), GA (OAPI patent), GB (European patent), IT (European patent), JP, LU (European patent), ML (OAPI patent), MR (OAPI patent), NL (European patent), SE (European patent), SN (OAPI patent), SU, TD (OAPI patent), TG (OAPI patent), US. Published <i>With international search report.</i>
(54) Title: SYSTEM FOR THE WATER-CULTURE OF PLANTS ON A CAPILLARY SUBSTRATE WITHIN A LIGHT-SELECTIVE FILM <div data-bbox="592 1081 1096 1543" data-label="Image">  </div> (57) Abstract <p>The system comprises one or more cultivation units (1), each of which comprises a tubular element (2) of opaque flexible material which is surface-treated so as to have a predetermined ratio between its absorbance and emittance, in such a way as to promote or prevent increases of its internal temperature. This tubular element (2) is laid on a horizontal support surface (G), and has apertures (3) for the introduction of the plants (P) to be cultivated. A layer of absorbent support material (12) is deposited in the tubular element (2) to function as a bed for supporting and nourishing the root systems of the plants (P). Liquids can be received, retained and diffused by capillary action in this layer in a transverse direction and in the direction of its thickness. In use, liquids (water, nutrients, etc.) are supplied to the absorbent support layer (12), without recirculation of the liquids, by means of a distributor tube (15) which extends longitudinally within the tubular element (2) adjacent the layer of absorbent material (12). The root system of the cultivated plants (P) are therefore located in the interface zone between the liquid-soaked absorbent support layer (12) and the overlying atmosphere confined within the tubular element (2).</p>		

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	GA	Gabon	MR	Mauritania
AU	Australia	GB	United Kingdom	MW	Malawi
BB	Barbados	HU	Hungary	NL	Netherlands
BE	Belgium	IT	Italy	NO	Norway
BG	Bulgaria	JP	Japan	RO	Romania
BR	Brazil	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic	KR	Republic of Korea	SE	Sweden
CG	Congo	LI	Liechtenstein	SN	Senegal
CH	Switzerland	LK	Sri Lanka	SU	Soviet Union
CM	Cameroon	LU	Luxembourg	TD	Chad
DE	Germany, Federal Republic of	MC	Monaco	TG	Togo
DK	Denmark	MG	Madagascar	US	United States of America
FI	Finland	ML	Mali		
FR	France				

- 1 -

System for the water-culture of plants on a capillary substrate within a light-selective film.

The present invention relates to a water-culture system for the cultivation of plants on a solid substrate soaked with nutrient solutions. The object of the present invention is to produce
5 an improved water-culture system which is simple and cheap both to produce and manage, and has characteristics that are superior to traditional methods of cultivation in soil, to the conventional methods of hydroponics and aeroponics, and to
10 so-called "film-cultivation".

According to the invention, this object is achieved by means of a water-culture system the principle characteristics of which will be clear from the appended Claim 1.

15 Further characteristics and advantages of the water-culture system according to the present invention will become apparent from the detailed description which follows with reference to the appended drawings, provided purely by way of non-limiting
20 example, in which:

Figure 1 is a perspective view of one embodiment of a cultivation unit of the system of the invention;

Figure 2 is a sectional view along the line II-II
25 of Figure 1;

Figures 3 to 5 are cross-sectional views of three embodiments of a tubular element used in the

- 2 -

system according to the invention;

Figure 6 is a section of a portion of a film with active surface layers, usable for making the tubular elements of Figures 3 to 5;

- 5 Figure 7 is a perspective view of a variant of the cultivation unit shown in Figure 1;

Figure 8 is a cross-sectional view along the line VIII-VIII in Figure 7;

- 10 Figure 9 is a schematic view of the more general configuration of a water-culture system according to the invention, and

Figures 10 and 11 show schematically two sensors used in the system of Figure 9.

- 15 A water-culture system according to the invention comprises one or more cultivation units of the type generally indicated 1 in Figure 1. In the embodiment shown in Figure 1, the cultivation unit comprises a tubular element 2 of opaque flexible material, which has a plurality of
20 spaced-apart apertures 3 along a generatrix. These apertures are of sufficient size to allow the introduction of respective plants P to be cultivated, and the development and growth of these plants (Figure 2). The tubular element
25 2 is laid in a horizontal position of a support surface G (Figure 2), for example a levelled and compacted piece of ground, possibly sprayed with solutions of binding substances, such as emulsified polymers, silicates, mortar mixtures

- 3 -

or inorganic cements, so as to provide a hardened surface layer g.

The ends of the tubular element 2 are sealed simply by being folded, for example downwardly, in such a way that they can be unfolded to allow inspection and possible interventions by a user. The tubular element may be formed integrally (tubular in the true sense of the term) as shown in Figure 3, it may be made from a folded and welded sheet as shown in Figure 4, or it may be formed by welding the edges of two juxtaposed sheets as shown in Figure 5.

The tubular element 2 is made from opaque flexible material composed, for example, of a thermoplastics film (PVC, low- or high-density polyethylene, etc) or a thin expanded plastics material. For some applications, it could be formed by welding two sheets of which the upper one consists, for example, of a plastics film, and the lower one of a film of an expanded, closed-cell plastics material. In each case, as will now be described, at least the upper portion of the tubular element 2 is surface-treated in such a way as to have surface layers active on the incident electromagnetic radiation to ensure a different proportion of the absorbance to the emittance from the typical absorbance and emittance of the material constituting the tubular element. With an appropriate choice of the material constituting the tubular element and of the materials of the active surface layers applied thereto, it is possible to promote or prevent temperature increases within the tubular.

- 4 -

element. This allows the realization of the optimum form of cultivation unit for the type of cultivation, the envisaged ambient temperature in which cultivation is to take place, 5 the latitude, the season of cultivation, etc.

Figure 6 illustrates schematically one embodiment of the upper sheet of the tubular envelope 2. In this embodiment, the upper sheet of the tubular element 2 consists of an opaque black 10 polyethylene film 4 with a top layer of aluminium, to which a layer of varnish of electrically semi-conducting material 6, for example titanium oxide, zinc oxide or zinc sulphide is applied.

The tubular element formed with the layered 15 structure shown in Figure 6 allows very efficient prevention of increases in its internal temperature, and is therefore adapted to dissipate heat in very hot periods or places.

On the other hand, if the tubular element 2 20 consists, for example, of a black polyethylene tube with a thin layer of white expanded polyethylene on its lower external surface, it permits the downward dissipation of heat to be retarded.

If the upper part of the tubular element 2 is 25 coated externally with a thin layer of copper, cobalt or nickel oxides or sulphides mixed, for example, with titanium or zinc oxides or zinc sulphides, the heat intake of the tubular element is promoted with a saturation effect above a 30 maximum threshold. This permits the maximum temperature within the tubular element to be limited, thus avoiding possible damage to the plants,

- 5 -

and at the same time allows the optimum utilization of the energy available in relatively colder places and periods.

In order to optimise the use of the solar energy available in periods and places characterised by intermediate conditions of solar irradiation, the tubular element 2 may be composed of a film of polyethylene or other black thermoplastics material coated externally on its upper part with a thin layer of zinc oxides or sulphides or titanium oxides.

The width of the tubular element 2 is dependent on the type of plant which is to be cultivated and, by way of example, the semicircumference of this tubular element could be between 15 and 40 cm. The length of the tubular element 2, of course, depends on the dimensions of the plot available for cultivation but is limited most of all by problems of uniform distribution of the liquids. The thickness of the film constituting the tubular element 2 is typically of the order of a few hundredths of a millimetre, for example between 0.02 and 0.06 mm.

Once it has been placed on the ground, the tubular element 2 is supported, for example, in the manner illustrated in Figure 1. A wire 7 extends longitudinally within the tubular element 2 adjacent the apertures 3, and emerges through two end holes 8 in the tubular element. The ends of the wire 7 are firmly attached to two uprights 9 fixed in the ground. The wire 7 holds the upper sheet or layer of the tubular envelope 2 at a pre-established height. In addition,

- 6 -

further vertical wires 10 usable as supports for the plants cultivated and as suspension elements for the wire 7 may be connected to this wire in correspondence with the apertures

- 5 3. The supporting wires 10 may be connected at their upper ends to a tensioning wire 11 stretched between the uprights 9, as illustrated by way of example in Figure 1.

- 10 Naturally, the tubular envelope 2 may be supported and anchored in many other ways, for example, with the use of more wires inside or outside the tubular element, etc.

- As shown, for example, in Figure 2, a thin layer of absorbent support material 12 is disposed
15 within the tubular element 2. This layer may be composed of any type of material capable of receiving, retaining and diffusing by capillary action the liquids in a transverse direction thereof and in the direction of its thickness.
20 It may be composed of a fibrous, expanded, sintered, granular, or laminated material. In particular, the thickness of this layer is between 0.5 and 10 mm.

- This layer serves as a bed for supporting the
25 root systems of the plants to be cultivated. Conveniently, the seeds of the plants to be cultivated are sown or germinated beforehand in a block of expanded, fibrous or granular material. The plant to be cultivated may also
30 consist of a cutting or shoot which is rooted in a block of this type and then placed in the cultivation units according to the invention. In Figure 2, a block of expanded material, indicated

- 7 -

13, serves as a support for the root system of a plant P. The blocks 13 may also serve as supports for the wire 7 described above, thus assisting in the support of the upper part of the tubular
5 element 2.

Extending longitudinally within the tubular envelope 2 is a distributor tube 14, preferably constituted by a tube of thin thermoplastics film (with a thickness, for example, of between 0.2 and
10 0.02 mm) the wall of which has a plurality of longitudinally spaced apertures 15 (Figure 2). The water necessary for the plants, the nutrient solutions, and any plant protection products, such as algicides, antiparasitic agents, and fungicides,
15 can be passed into the cultivation unit through this tube. These liquids pass through the apertures 15 of the distributor tube 14, soak into the absorbent layer 12, and are diffused by capillary action. The roots of the plants P (Figure 2) may draw water,
20 nutrients, etc. from the absorbent layer 12 which serves as a support bed and serves for the distribution of the nutrient solutions. The root systems of the plants to be cultivated are therefore located in the interface zone between the liquids
25 carried by the absorbent layer 12 and the overlying atmosphere confined within the tubular element 2.

The distributor tube 14 emerges from the envelope 2 through an end aperture 16 of this envelope.

A very important characteristic of the invention
30 resides in the fact that the liquids supplied to the cultivation unit are not recirculated. This solution involves a number of advantages which will be described below, and is possible because it is no

- 8 -

longer necessary to dissipate excess heat by the circulation of liquids, since this task can be effected, when necessary, by the surface layers of the tubular element, as described previously.

- 5 Moreover, this solution is allowed by the addition to the absorbent layer of substances capable of adsorbing the catabolites produced by the plants, so that these do not damage the plants, particularly in the case of plants with a longer "cycle".
- 10 In particular, when the system according to the invention is set up in closed environments such as greenhouses, it is possible to use the distributor tube 14 or the tubular element 2 of the cultivation units as distributors of carbon dioxide where
- 15 so-called "carbon fertilisation" is to be carried out.

- Conveniently, the absorbent layer 12 may have colloidal additives (for example carboxymethyl cellulose alginates, polyacrylamide, bentonite, etc.)
- 20 capable of retaining a volume of liquid greater than their own volume.

- In addition, as described above, adsorbent substances capable of adsorbing the catabolites produced by the cultivated plants may be added conveniently
- 25 to the absorbent layer. For this purpose, it is possible to use, for example, activated bentonite, aluminium oxide or charcoal.

- Macro- and micro-nutrients necessary for the feeding of the plants, in the form of controlled-release
- 30 compositions, may also be added to the absorbent layer 12.

- 9 -

Figures 7 and 8 show a variant of the cultivation unit described in the above, containing two rows of plants and a distributor tube 14 between the rows.

Naturally, multi-row structures may be produced, possibly with more distribution tubes.

Figure 9 shows schematically the configuration of a water-culture system according to the invention, comprising a plurality of cultivation units 1 of the type described above. This system comprises
10 a water reservoir 20 connected to supply tubing 21 by means of a feed pump 22 with an electric drive motor 22a. A solenoid on-off valve V is positioned downstream of the pump 22. The supply tubing 21 is connected to the distribution
15 tubes 14 of the cultivation units 1. Further water reservoirs 23 - 26 are also connected to the supply tubing 21 through respective metering pumps 27 - 30 provided with electric drive motors 27a - 30a. The reservoirs 23 - 26 contain, for
20 example, in order, acids or bases, macro-nutrients excluding calcium (and possibly with added plant protection products), micro-nutrients and calcium salts.

Also interposed along the supply tubing 21, upstream
25 of the cultivation unit 1, are a controlled heater 49, a temperature sensor 50, a gate valve 51, and a pressure regulator 52 with a pressure gauge and a meter 53. An electronic control and operating unit, indicated 40, is connected to the motor
30 22a of the feed pump 22, the motors 27a - 30a of the metering pumps 27-30, and to the devices V, 49, 50, 53 described above.

- 10 -

A temperature sensor 43 is disposed within the tubular envelope 2 of at least one cultivation unit 1 and, above the layer of absorbent material 12, are a pH meter 41, a conductivity meter 42 and a sensor 44 for detecting the amount of liquid in the absorbent support layer 12. The sensors 41 to 44 are connected to the electronic control and operating unit 40.

Figure 10 illustrates an embodiment of the sensor 44 for detecting the amount of liquid in the absorbent support layer 12. In this embodiment, the sensor comprises a rectangular frame 60 placed on the absorbent support layer 12. A rigid plate 61 (made for example of metal) is articulated at one end about a pivot 62 fixed to two opposite parts of the frame 60. The lower face of the plate 61 is exactly in contact with the upper surface of the absorbent support layer 12. When this layer is soaked with liquid, the plate 61 adheres to this layer in such a way that the force necessary to effect its detachment is a function of the amount of liquid in the layer 12.

The end of the plate 61 opposite the pivot 62 is connected to one end of a wire 63 passing over a pulley 64. A counterweight 65 connected to the other end of the wire 63 tends to cause the detachment of the plate 61. The weight of the counterweight 65 is chosen in such a way that the plate 61 is detached from the absorbent layer 12 when the amount of liquid absorbed by this layer falls below a predetermined level. A position sensor 66 detects the movement of the counterweight 65 and thus signals to the electronic control and

- 11 -

operating unit 40 whether the amount of liquid in the absorbent layer 12 is sufficient or insufficient. The plate 61 can be returned to the lowered working position by means of an
5 electromagnet 67 piloted by the control and operating unit 40.

Conveniently, a further sensor, schematically indicated 70 in Figure 9 and better illustrated in Figure 11, may be associated with each
10 cultivation unit 1. This sensor comprises substantially a rigid plate 71 arranged beneath the tubular envelope 2 of the cultivation unit 1, in the manner illustrated in Figure 11, thus forming a small angle of, for example,
15 5 to 10° with the ground. An electric pressure sensor 72 of known type is interposed between the raised end of the plate 71 and the support surface G. In use, the information supplied to the control and operating unit 40 by the sensor 72 is
20 indicative of both the variation in the quantity of liquid in the absorbent layer 12 and the degree of growth achieved by the plants cultivated: the two information signals are clearly distinguishable from one another.

25 The control and operating unit 40 is programmed by conventional programming techniques to carry out irrigation and feeding cycles for the cultivation units 1, the cycles being carried out by the piloting of the pumps 22, 27-30, and the regulating
30 and measuring devices 49, 50, 53 on the basis of the information signals reaching this unit from the sensors described above, according to a pre-established scheme dependent on the type of crop.

-12 -

The system according to the invention has numerous advantages.

First of all, the cultivation units can be made from very cheap materials. The initial
5 economic investment necessary for installing such cultivation units is very modest.

The system may be used on any type of land, therefore even on barren, rocky or desert soil, and does not require the availability of agricultural
10 machinery or other expensive equipment. The supervision and the management of the system does not require particularly skilled personnel. The cost involved in managing the system is thus very low, especially in view of the fact that the
15 maintenance of the system is extremely simple. Moreover, the system requires very limited use of chemicals against plant diseases, since the materials constituting the cultivation units are sterile and non-biodegradable over the periods
20 that they are used (therefore being less suited to the nutrition of phytopathogenic germs). The possibility of root diseases is reduced since the neck zone of the plant is aerated; when the system is set up in a closed environment
25 (greenhouse), since no spray-irrigation is carried out and since the manufactured article does not favour evaporation, the confined atmosphere does not have dangerous increases in humidity and the consequent risk of plant diseases.

30 The system according to the invention has considerable advantages compared with all the types of cultivation of the prior art.

- 13 -

Compared with cultivation in soil, a first advantage is constituted by the fact that it is possible constantly to control the composition of the nutrient solutions and that the plants cultivated
5 are healthier through being fed more correctly and being less susceptible to diseases caused by bacteria, fungi, insects, earthworms, etc. Furthermore, optimum use is made of the water, since none is lost through seepage or through
10 evaporation from the ground. In addition, it is possible to heat the circulating solutions to promote rooting or growth. Furthermore, the system according to the invention does not have the problem of crop-rotation which is essential,
15 however, for crops cultivated in soil because of accumulations of catabolites or specific parasites. Moreover, the system does not require any manual or chemical weeding to be carried out, because of a total absence of infesting
20 plants. The plants cultivated are also extremely clean and therefore more presentable at market. Also from the aspect of hygiene, the plants cultivated are completely free of any micro-organisms pathogenic to man.

25 Compared with hydroponic-type cultivation, the system according to the invention has the advantage of not requiring any aeration, since the roots are in constant contact with air. The equipment necessary is also much more modest and
30 economical: there is no need for the blowers, lights, tanks and filling materials required for hydroponic cultivation, nor is there any need for the sprinklers necessary for aeroponic cultivation. The maintenance of the system is

- 14 -

also extremely simple. Conveniently, moreover, in the system according to the invention, the cultivation units are of the type which are disposable at the end of the cultivation process.

- 5 This is possible because they are cheap and it eliminates the need to sterilize and clean the cultivation units after cultivation.

The distribution of the liquid without recirculation ensures an optimum supply of salts, and also
10 involves a saving on expensive analytical equipment which is necessary in systems with circulation. In addition, the recirculation of catabolites, pathogens and infectants is avoided in the cultivation units.

- 15 Compared with so-called "film-cultivations", the system according to the invention has an advantage residing in the fact that the nutrient solutions are distributed in a more uniform manner around the root systems of the
20 plants, since the solutions are diffused by capillary action through the absorbent layer 12 and distribution does not take place in "trickles". Moreover, there is no danger of any leakage and waste of nutrient solution if the tubular
25 envelope and the cultivation unit are ruptured, since the solutions are retained in the absorbent layer 12 by capillary action. The management of the system proves significantly economical, in that it requires less energy for pumping the liquids,
30 whether because the difference in level to be negotiated is less, or because there is no need to circulate the liquids for the purpose of heat dissipation.

CLAIMS

1. A water-culture system for the cultivation of plants on a solid substrate soaked with nutrient solution, characterised in that it comprises one or more cultivation units (1),
5 each of which comprises:
a tubular element (2) of opaque material surface-treated so as to have surface layers (5, 6) with predetermined characteristics of absorbance and emittance, which act on the incident electromagnetic
10 radiation in such a way as to promote or prevent temperature increases within the tubular element (2), said tubular element (2) having a plurality of spaced-apart apertures (3) for the introduction and passage of respective plants (P), and being
15 intended to be laid in a substantially horizontal position on a support surface (G) with the apertures (3) preferably facing upwards;
a layer (12) of absorbent support material for the receiving, retaining and diffusing through
20 capillary action of liquids in a transverse direction and in the direction of its thickness, said layer (12) being arranged in the tubular element (2) in a position facing the said apertures (3) and being intended to function as a bed for supporting and
25 nourishing the root systems of the plants (P) to be cultivated; and
feeding and control means for supplying liquids to the absorbent support layer (12) within the tubular element (2)
30 without recirculation, in such a way that the level of liquids within the tubular element (2) does not substantially exceed the thickness of the absorbent support layer (12) and the root systems of the cultivated plants (P) are located in the
35 interface zone between the liquids carried by the

- 16 -

absorbent layer (12) and the overlying atmosphere confined within the tubular element (2).

2. A system according to Claim 1, characterised in that the tubular element (2) is of flexible
5 material.

3. A system according to Claim 1 or 2, characterised in that each cultivation unit (1) also includes support and anchoring means (7-9) for supporting and anchoring the tubular element
10 (2) on the support surface (G).

4. A system according to any one of the preceding claims, characterised in that the tubular element (2) is black on at least its internal surface.

15 5. A system according to any one of the preceding claims, characterised in that the tubular element (2) is constituted at least in part by a plastics film.

20 6. A system according to Claim 4, characterised in that the tubular element (2) is constituted at least in part by an expanded plastics material.

7. A system according to Claim 5 or 6, characterised in that the tubular element (2) is constituted at least in part by combined laminates.

25 8. A system according to any one of Claims 5 to 7, characterised in that the material constituting the tubular element (2) is provided with a thin layer of metallic material (5) on at least a part of its outer surface.

- 17 -

9. A system according to Claims 5 and 8, characterised in that the tubular element (2) is constituted by a film of opaque black thermoplastics material (4) carrying a layer of electrically semi-conducting material (6) on at least the portion of its outer surface which faces upwardly in the installed condition.
10. A system according to Claim 9, characterised in that the semi-conducting material is an oxide.
- 10 11. A system according to Claim 9 or 10, characterised in that the semi-conducting material is chosen from the group comprising sulphides and oxides of nickel, cobalt, zinc, copper, lead, and oxides of titanium.
- 15 12. A system according to any one of the preceding claims, characterised in that the thickness of the wall of the tubular envelope (2) is generally of the order of a few hundredths of a millimetre.
- 20 13. A system according to any one of the preceding claims, characterised in that the tubular element (2) may also be used for the distribution of CO₂ (carbonic fertilization), when the system is set up in a closed environment such as a greenhouse.
- 25 14. A system according to any one of the preceding claims, characterised in that the layer (12) of absorbent support material is constituted at least in part by one or more of the following materials: plastics material, fibrous
- 30

- 18 -

material, expanded material, sintered material, granular material, and laminated material.

15. A system according to Claim 14, characterised in that the material constituting the
- 5 absorbent support layer (12) has colloidal additives capable of retaining a volume of liquid greater than their own volume.
16. A system according to Claim 15, characterised in that the colloids are selected from the groups
- 10 comprising carboxymethyl cellulose, alginates, polyacrylamide, bentonite, etc.
17. A system according to any one of Claims 14 to 16, characterised in that the absorbent support layer (12) is constituted at least in part by felt.
- 15 18. A system according to one of Claims 14 to 17, characterised in that the absorbent support layer (12) has additives of adsorbent substances capable of adsorbing the catabolites produced by the plants cultivated.
- 20 19. A system according to Claim 18, characterised in that the layer of absorbent material (12) has an additive of a substance from the group including activated charcoal, aluminium oxide and bentonite.
- 25 20. A system according to any one of the preceding claims, characterised in that the layer of absorbent material (12) has additives of macro- and micro-nutrients in the form of controlled-release compositions.

21. A system according to any one of the preceding claims, characterised in that the layer of absorbent material (12) has a thickness of less than 10 mm.

5 22. A system according to any one of the preceding claims, characterised in that the support and anchoring means comprise at least one supporting wire or tape (7) extending longitudinally of the tubular element (2) at a pre-established
10 height from the support surface (G) on which the tubular element (2) is placed, said at least one wire (7) being connected to the upwardly-facing portion of the tubular element (2) so as to hold this position at a pre-established distance
15 from the support surface (G).

23. A system according to Claim 22, characterised in that said at least one wire (7) extends within the tubular element (2) adjacent the apertures (3), and emerges from the tubular element (2)
20 through two end apertures (8) thereof.

24. A system according to Claim 23, characterised in that support elements (10) for supporting the plants (P) under cultivation are connected to said at least one wire (7) in correspondence
25 with the apertures of the tubular element (2).

25. A system according to any one of the preceding claims, characterised in that the ends of the tubular element (2) are closed with a liquid-tight seal by being folded upwardly or downwardly, said folding
30 being of the unfoldable type.

- 20 -

26. A system according to any one of the preceding claims, characterised in that the feeding and control means include a liquid distribution tube (14) arranged longitudinally within the tubular
5 element (2) adjacent the absorbent support layer (12), the wall of the distribution tube (14) having a plurality of longitudinally spaced apertures (15) through which the liquids fed to the tube (14) are distributed and diffused longitudinally of the
10 absorbent support layer (12).

27. A system according to Claim 26, characterised in that the feeding and control means include:

a water reservoir (20);

supply tubing (21) connected at one end
15 to the water reservoir (20) by means of a feed pump (22), and at the other end to the distribution tube (14) of said at least one cultivation unit (1), a plurality of reservoirs (23-26) for concentrated solutions of, for example, acids or bases, macro-nutrients,
20 and micro-nutrients being connected to the supply tubing (21), each of these reservoirs (23-26) being connected to the supply tubing (21) through means a respective metering pump (27-39); and

a control and operating unit (40) connected to
25 the motors (22a; 27a-30a) of the feed pump (22) and the metering pumps (27a, 30) and prearranged to activate and deactivate the pumps (22, 27-30) according to pre-established procedures.

28. A system according to Claim 27, characterised
30 in that at least one cultivation unit (1) is provided with:

means (41, 42) for measuring the pH and the electrical conductivity of the liquids with which the layer of absorbent support material (12) is
35 soaked;

electrical temperature sensing means (43);
means (44) for measuring the amount of liquid
in the absorbent support layer (12), and
means (70) for measuring the weight of at
least one longitudinal portion of the layer of
absorbent support material (12);
said measuring means (41 to 44, 70) being
connected to the electronic control and operating
unit (40).

29. A system according to Claim 28, characterised
in that the means (44) for measuring the amount of
liquid in the absorbent support layer (12) comprise
a rigid plate (61) placed on the layer (12) and
adhering to this layer in such a way that the force
required for its detachment therefrom is a function
of the amount of liquid in the layer (12);

counteracting means (65) which tend to
raise the plate (61), and

electrical sensor means (66) for detecting
the movement of the counteracting means (65).

30. A system according to Claim 27 or 28,
characterised in that one or more of the following
devices is interposed along the supply tubing (21):

a flow regulator (51),
a flow meter (53),
a temperature sensor (50),
a pressure regulator (52) provided with a
pressure gauge, and
an electrically controlled heater (49).

31. A water-culture system, characterised in that
it comprises a plurality of cultivation units
(1) according to one or more of the preceding claims,
connected to a single distribution and control system.

- 22 -

32. A system according to any one of the preceding claims, characterised in that it includes a plurality of blocks (13) of expanded plastics material, in each of which a respective
5 seedling is rooted or germinated.

33. A process for the water-culture of plants on a solid substrate soaked with nutrient solutions, by the use of a water-culture system according to one or more of the preceding claims.

1/2

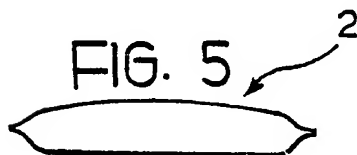
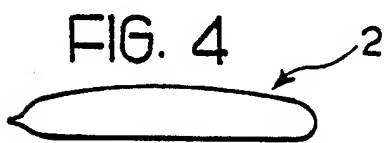
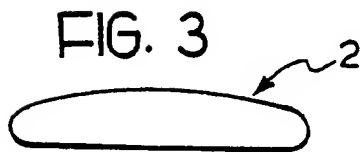
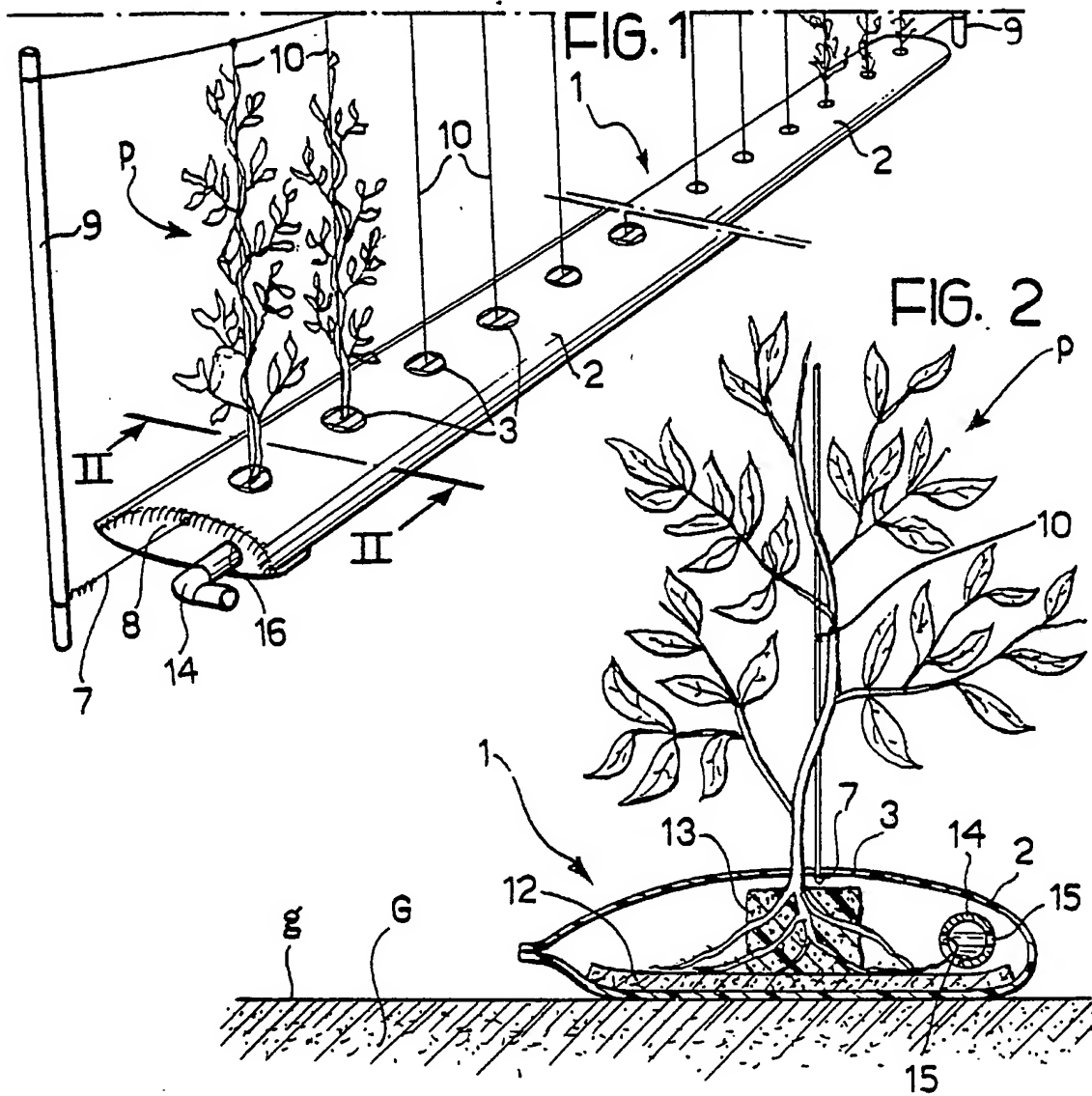
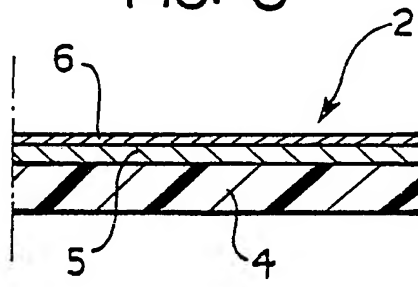
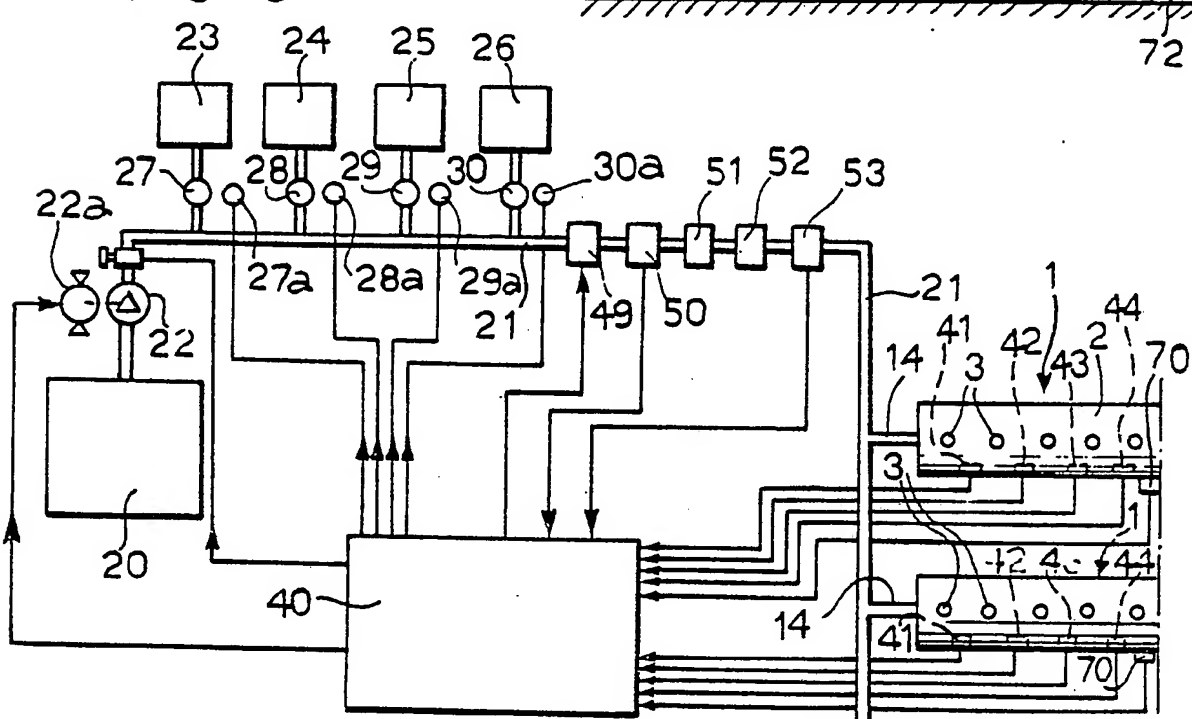


FIG. 6





INTERNATIONAL SEARCH REPORT

International Application No PCT/EP 85/00340

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) * According to International Patent Classification (IPC) or to both National Classification and IPC IPC ⁴ : A 01 G 31/02																							
II. FIELDS SEARCHED <div style="text-align: center; margin-top: 10px;">Minimum Documentation Searched *</div> <table style="width: 100%; border: none;"> <tr> <td style="width: 30%; border-bottom: 1px solid black; padding-bottom: 5px;">Classification System</td> <td style="border-bottom: 1px solid black; padding-bottom: 5px;">Classification Symbols</td> </tr> <tr> <td style="padding: 5px;">IPC⁴</td> <td style="padding: 5px;">A 01 G</td> </tr> </table> <div style="text-align: center; margin-top: 10px;">Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched *</div>			Classification System	Classification Symbols	IPC ⁴	A 01 G																	
Classification System	Classification Symbols																						
IPC ⁴	A 01 G																						
III. DOCUMENTS CONSIDERED TO BE RELEVANT * <table style="width: 100%; border: none;"> <tr> <th style="width: 10%; border-bottom: 1px solid black; padding-bottom: 5px;">Category *</th> <th style="width: 70%; border-bottom: 1px solid black; padding-bottom: 5px;">Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²</th> <th style="width: 20%; border-bottom: 1px solid black; padding-bottom: 5px;">Relevant to Claim No. ¹³</th> </tr> <tr> <td style="padding: 5px; vertical-align: top;">A</td> <td style="padding: 5px;">AT, B, 312351 (SEMPERIT) 27 December 1973, see page 2, line 54 - page 3, line 2 - figures 1,2 --</td> <td style="padding: 5px; vertical-align: top;">1,2,4,5,6, 14,26,32,33</td> </tr> <tr> <td style="padding: 5px; vertical-align: top;">A</td> <td style="padding: 5px;">GB, A, 1320940 (SEMPERIT) 20 June 1973, see page 3, line 120 - page 4, line 10; page 5, line 92 - page 6, line 31; claims 1,7,8,9,10; figures 12,13,14 --</td> <td style="padding: 5px; vertical-align: top;">1,2,5,6,14, 20,26</td> </tr> <tr> <td style="padding: 5px; vertical-align: top;">A</td> <td style="padding: 5px;">FR, A, 2341263 (PHYTOTRONIC AND HYDROPONIC RESEARCH) 16 September 1977, see page 2, line 5 - page 4, line 16 - figures 1-6 --</td> <td style="padding: 5px; vertical-align: top;">1</td> </tr> <tr> <td style="padding: 5px; vertical-align: top;">A</td> <td style="padding: 5px;">GB, A, 2130465 (THE GREEN DESERT CO.) 6 June 1984, see page 2, line 74 - page 5, line 59 - figure 1 --</td> <td style="padding: 5px; vertical-align: top;">1,14</td> </tr> <tr> <td style="padding: 5px; vertical-align: top;">A</td> <td style="padding: 5px;">US, A, 3300895 (MIROSLAV DOSEDLA) 31 January 1967, see column 2, line 38 - column 3, line 9; figure 1 --</td> <td style="padding: 5px; vertical-align: top;">24</td> </tr> <tr> <td style="padding: 5px; vertical-align: top;">A</td> <td style="padding: 5px;">US, A, 3578431 (INGESTAD) 11 MAY 1971, see column 2, lines 31-59; figure -----</td> <td style="padding: 5px; vertical-align: top;">28</td> </tr> </table>			Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³	A	AT, B, 312351 (SEMPERIT) 27 December 1973, see page 2, line 54 - page 3, line 2 - figures 1,2 --	1,2,4,5,6, 14,26,32,33	A	GB, A, 1320940 (SEMPERIT) 20 June 1973, see page 3, line 120 - page 4, line 10; page 5, line 92 - page 6, line 31; claims 1,7,8,9,10; figures 12,13,14 --	1,2,5,6,14, 20,26	A	FR, A, 2341263 (PHYTOTRONIC AND HYDROPONIC RESEARCH) 16 September 1977, see page 2, line 5 - page 4, line 16 - figures 1-6 --	1	A	GB, A, 2130465 (THE GREEN DESERT CO.) 6 June 1984, see page 2, line 74 - page 5, line 59 - figure 1 --	1,14	A	US, A, 3300895 (MIROSLAV DOSEDLA) 31 January 1967, see column 2, line 38 - column 3, line 9; figure 1 --	24	A	US, A, 3578431 (INGESTAD) 11 MAY 1971, see column 2, lines 31-59; figure -----	28
Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³																					
A	AT, B, 312351 (SEMPERIT) 27 December 1973, see page 2, line 54 - page 3, line 2 - figures 1,2 --	1,2,4,5,6, 14,26,32,33																					
A	GB, A, 1320940 (SEMPERIT) 20 June 1973, see page 3, line 120 - page 4, line 10; page 5, line 92 - page 6, line 31; claims 1,7,8,9,10; figures 12,13,14 --	1,2,5,6,14, 20,26																					
A	FR, A, 2341263 (PHYTOTRONIC AND HYDROPONIC RESEARCH) 16 September 1977, see page 2, line 5 - page 4, line 16 - figures 1-6 --	1																					
A	GB, A, 2130465 (THE GREEN DESERT CO.) 6 June 1984, see page 2, line 74 - page 5, line 59 - figure 1 --	1,14																					
A	US, A, 3300895 (MIROSLAV DOSEDLA) 31 January 1967, see column 2, line 38 - column 3, line 9; figure 1 --	24																					
A	US, A, 3578431 (INGESTAD) 11 MAY 1971, see column 2, lines 31-59; figure -----	28																					
<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>* Special categories of cited documents: ¹⁰</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 50%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&" document member of the same patent family</p> </div> </div>																							
IV. CERTIFICATION <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; border-bottom: 1px solid black; padding-bottom: 5px;">Date of the Actual Completion of the International Search</td> <td style="width: 50%; border-bottom: 1px solid black; padding-bottom: 5px;">Date of Mailing of this International Search Report</td> </tr> <tr> <td style="padding: 5px;">27th September 1985</td> <td style="padding: 5px;">31 OCT 1985</td> </tr> <tr> <td style="width: 50%; border-bottom: 1px solid black; padding-bottom: 5px;">International Searching Authority</td> <td style="width: 50%; border-bottom: 1px solid black; padding-bottom: 5px;">Signature of Authorized Officer</td> </tr> <tr> <td style="padding: 5px; text-align: center;">EUROPEAN PATENT OFFICE</td> <td style="padding: 5px; text-align: center;"> G.L.M. Cruvdenberg </td> </tr> </table>			Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	27th September 1985	31 OCT 1985	International Searching Authority	Signature of Authorized Officer	EUROPEAN PATENT OFFICE	 G.L.M. Cruvdenberg													
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report																						
27th September 1985	31 OCT 1985																						
International Searching Authority	Signature of Authorized Officer																						
EUROPEAN PATENT OFFICE	 G.L.M. Cruvdenberg																						

Form PCT/ISA/210 (second sheet) (January 1985)

INTERNATIONAL APPLICATION NO. PCT/EP 85/00340 (SA 10050)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 08/10/85

The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
AT-B- 312351	15/11/73	JP-A- 49066423	27/06/74
GB-A- 1320940	20/06/73	NL-A- 7014511	06/04/71
		DE-A- 2047820	15/04/71
		FR-A- 2064925	23/07/71
		CH-A- 540636	15/10/73
		AT-A, B 313628	15/01/74
FR-A- 2341263	16/09/77	OA-A- 5621	30/04/81
GB-A- 2130465	06/06/84	None	
US-A- 3300895		None	
US-A- 3578431	11/05/71	NL-A- 6613602	03/04/67
		CH-A- 484601	31/01/70
		BE-A- 687183	01/03/67
		DE-A- 1542807	25/03/71

For more details about this annex :
see Official Journal of the European Patent Office, No. 12/82